

Drupe - a term in search of a definition

H. Trevor Clifford and Mary E. Dettmann

Summary

Clifford H. Trevor and Dettmann, Mary E. (2001). Drupe - a term in search of a definition, *Austrobaileya* 6 (1): 127–131. The term drupe as defined in modern Australian Floras has several meanings and is often employed inconsistently. Reasons for the various usages are offered and a new definition of the term proposed.

Key words: drupe, drupaceous, exocarp, epicarp, mesocarp, endocarp

H. Trevor Clifford, Honorary Associate, Queensland Herbarium, Environmental Protection Agency, Brisbane Botanic Gardens Mt Coot-tha, Mt Coot-tha Road, Toowong 4066.

Mary E. Dettmann, Botany Department, The University of Queensland, 4072.

Introduction and discussion

The need for a precise definition of the term drupe arose during a study of fossils described as “endocarp species” and presumed to represent the inner woody layers of drupes. Reference to recent Australian Floras revealed that there is a diversity of opinion as to the definition of the term drupe. Some authors (Carolin & Tindale 1994; McCusker 1981; Harden 1990; Beadle 1971; Walsh & Entwistle 1994) restrict the term to the product of a monocarpellary ovary whereas others (Stanley & Ross 1983; Jessop & Toelken 1986; Curtis & Morris 1975) ignore carpel number. Furthermore, there is inconsistency in the use of the term drupe especially by those who claim it develops from a monocarpellary ovary.

Thus, Walsh & Entwistle (1994) qualify their definition of drupe as monocarpellary by citing three examples of which only the peach is appropriate. The other two examples are the bicarpellary olive, and *Nitraria billardieri* DC. which is tricarpeal. It is ironic that in this context the olive is an inappropriate example of a drupe because Linnaeus (1751), when he coined the term, presumably assumed his readers would know that *dryppa* [Greek] and *drupa* [Latin] were words that in classical times referred to ‘an over-ripe wrinkled olive’ and so did not refer to the plant by name in either his text (p.53) or accompanying figure (Tab. VIII, Fig. 157)

It should be noted that Linnaeus (1753) regarded both the peach and olive as monogynous. He was not familiar with the term carpel for it was not coined until 1817 almost forty years after his death. Originally employed for divisions of a fruit the term now applies to a gynoecium in any stage of its development (Stearn 1992).

The adjectival term drupaceous is also widely used in Australian literature but usually without adequate definition. Exceptions are Beadle (1971) and Carolin & Tindale (1994) who having accepted the drupe as monocarpellary, defined drupaceous as applying to fruits ‘with the structure of a drupe but derived from more than one carpel’. An alternative approach to the problem of incorporating carpel number into the definition of drupe is that of Takhtajan (1991) who proposed that such a fruit be described as apocarpous or syncarpous according to the ovary type from which it develops. Although the definitions of drupe may vary in their concept of the number of carpels involved, all acknowledge the fruit contains a stone or stones derived solely from the endocarp. Monocarpellary ovaries have a single stone enclosing one (peach) or more than one seed (some *Persoonia* species). In contrast those that are syncarpous have either several one-seeded stones (*Leucopogon* species) or a single stone with one (*Semecarpus australiensis* Engl.) or more loculi of which one or more usually contain seeds the remainder being empty and sometimes compressed (*Elaeocarpus* species).

Alternative names for stone are shell, pyrene, putamen and endocarp each of which has been more or less widely used interchangeably in the literature. Likewise both epicarp and exocarp have been employed as alternative terms for the skin or outermost layer of the drupe. For example, Jessup (1985), who has written extensively on genera occurring in both Australia and south-east Asia has followed Dutch terminology in referring to the outermost layer of the drupe as the exocarp (Hou 1978). In contrast most Australian glossaries refer to the tissue as the epicarp. Exceptions are in the glossaries of Stanley & Ross (1983), Walsh & Entwistle (1994), Harden (1990) and Jessop & Toelken (1986) who define the exocarp as the epicarp plus mesocarp in which sense the term is also used by some palaeobotanists including (Reid and Chandler 1933: p.30).

Furthermore, terminological confusion may also arise when portions of drupes are defined in terms of other fruit types as when Curtis & Morris (1975) defined the pyrene as 'a nutlet of a several-seeded drupe'. The incorporation of nutlet in the definition could be regarded as compromising the integrity of both fruit types, notwithstanding that in their definition the authors made it clear that in popular usage the term nutlets is widely applied to fruit segments which technically are not small nuts.

The most recent classification of fruits (Spjut 1994) described the drupe as 'a fleshy pericarpium or fruit with one or more stones'. This definition lacks any reference to either carpel number or the origin of the woody or bony tissue but is misleading in that it could be taken to suggest the stone is not part of the pericarp. In what follows there is further confusion in that he also states 'Drupe may consist of one or more stones', although it is possible that 'contain' rather than 'consist of' was intended. Furthermore, by defining a drupe with reference to the pericarp, Spjut has restricted the term to fruits which develop from superior ovaries. The pericarp, as widely understood, refers to a fruit wall that has developed from that of an ovary rather than an ovary plus its associated receptacle.

By defining the term drupe solely on its

mature anatomy, Spjut (1994) has adopted a descriptive definition of the term. In contrast, those who relate the tissues of the fruit wall to those of the ovary from which it developed have an interpretive definition which, in most instances, is unsupported by developmental anatomical studies. This situation is unfortunate for, as stressed by Roth (1977), the anatomical development of relatively few fruits has been documented.

Therefore, it is not surprising that definitions of the term drupe based on surmise as to the developmental pathways of their anatomy should lead to conflicting interpretations of their anatomy. By way of example, the drupe as defined by Jessop & Toelken (1986), has a pericarp which 'consists of three layers (1) the epicarp or skin, (2) the mesocarp or juicy layer and (3) the bony endocarp or stone'. Such a definition prescribes that the mesocarp be juicy and the endocarp bony or woody. However, as was long ago observed by Hill (1934) the mesocarp of the fruit of *Pleiogynium timorense* (DC.) Leenh. is differentiated into two layers, the inner of which is thick and woody and the outer thin and fleshy (Fig.1 A). With the fruit of the closely related *Rhodospaera rhodanthema* (F.Muell.) Eng. the outer fleshy tissue is so thin that Jessup (1985) thought it appropriate to describe the entire mesocarp as woody.

Although such a fruit does not match any current definition of drupe it is only a somewhat more extreme example of the situation which obtains with *Pleiogynium timorense*. The inadequacy of comparative anatomy for determining fruit type is indicated by the diversity of terms currently applied to the fruit of *Hicksbeachia pinnatifolia* F.Muell. These include the following - typical drupe (Rao 1971), indehiscent drupe (Stanley & Ross 1983), hard drupe (Beadle 1971), drupaceous (Johnson & Briggs 1975), nut (Filla 1926) and fleshy indehiscent follicle (Floyd 1978).

Anatomical studies of the developing ovary wall of this species (Strohschen 1986) have revealed that the woody layer of the fruit derives from the inner mesocarp and not the endocarp and so the fruit is not a drupe. Nor is it a nut or follicle. Perhaps it was this uncertainty

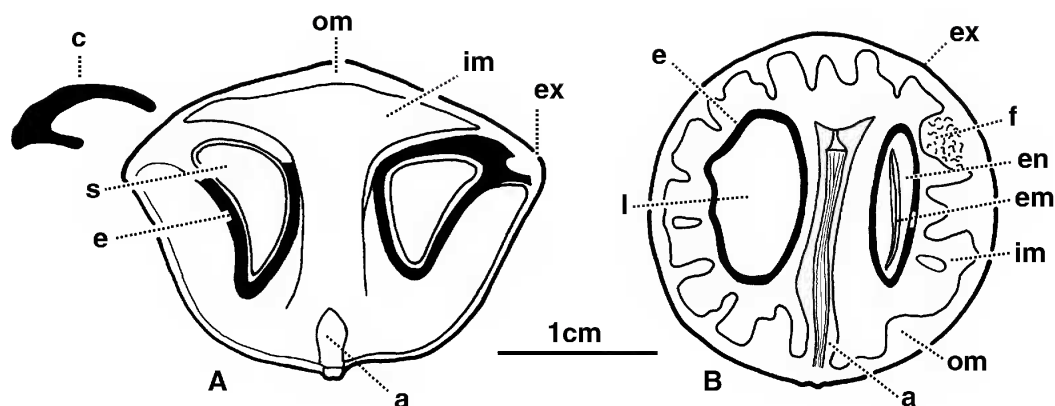


Fig. 1. Stones of *Pleio gynium timorense* (A) and *Elaeocarpus grandis* (B) in vertical section. a, axis; e, endocarp; en, endosperm; em, embryo; ex, exocarp; f, fibres; im, inner mesocarp; om, outer mesocarp; l, locule; s, seed. A, redrawn from Hill (1933).

as to the nature of the fruit that led Weston (1995) to describe but not name fruits of *Hicksbeachia*, *Athertonia* and *Catalepidia* in his Flora of Australia treatment of these genera.

A cursory survey of Australian species whose fruits are drupes derived from syncarpous ovaries has indicated that many have a woody inner mesocarp in which are encased the woody endocarps surrounding each seed as with *Pleio gynium timorense*. A notable example is *Elaeocarpus grandis* F. Muell. (Fig.1B) whose stones resemble permineralised fossils described from Oligocene sediments of central Queensland under the name *Elaeocarpus spackmaniorum* Rozefelds (Rozefelds 1990). A further complication in terminology arises when the term drupe is applied to the fruit of *Chrysanthemoides monilifera* (L.) Norlindh which is derived from an inferior ovary and so derived in part from a receptacle, a situation not allowed for by any definition of drupe.

Accordingly, there is little agreement amongst taxonomists as to the fruit type of *C. monilifera* with some describing it as a drupe (Stanley & Ross 1986, Short 1999) others as drupe-like (Brown 1992) or a cypselia (Carolin & Tindale 1994). Obviously, the term drupe has been applied to a diversity of fruits without regard to adequate knowledge of their developmental anatomy. Nonetheless, inconsistency between the usage of a term and its application in the subsequent text should be avoided.

Conclusion

The term drupe because of its long and useful history in descriptive taxonomic botany deserves to be retained subject to agreement as to its definition. Until more information is available on the development of fleshy fruits with a stone or stones surrounding the seeds it would be helpful to have a definition of drupe based solely on anatomy.

The following definition of drupe is proposed:-

Drupe: A fruit whose wall has three distinct tissues - an outer membranous or chartaceous skin enclosing a zone of more or less fleshy tissue surrounding one or more woody, bony or parchment-like stones each of which if fertile contains one or more seeds. The term stone may be replaced by pyrene. Drupes may be either apo- or syncarpous, if the latter the stone may be unilocular or plurilocular and with respect to the receptacle the drupe may be superior or inferior. Plurilocular drupes may contain several pyrenes or these may be embedded in a woody tissue derived from the inner mesocarp to form a single stone.

With the passage of time the stones of plurilocular drupes may separate passively (*Elaeocarpus* species) or explosively into segments (*Petalostigma* species).

In combination these characters could be employed, to define a range of drupes, some examples of which from the Australian flora are

listed below.

1. *Persoonia* apocarpous
2. *Pleiogynium* syncarpous, superior, plurilocular
3. *Elaeocarpus* syncarpous, superior, 2-plurilocular
4. *Semecarpus* syncarpous, superior, unilocular
5. *Chrysanthemoides* syncarpous, inferior, unilocular
6. *Coelospermum* syncarpous, inferior, 4-locular

The drupes of these genera differ significantly in structure and so it could be argued merit different names. Nonetheless, until the developmental anatomy of fruits with flesh surrounding a stone or stones is better known it would be premature to replace the term drupe with a plethora of names. Instead it would appear preferable to retain the word drupe, defined solely on anatomical characters, and qualify its use with appropriate descriptive adjectives.

Acknowledgements

The authors are grateful to Laurie Jessup for his helpful comments on an early draft of this paper and to Jeremy Bruhl for assistance in supplying photocopies of the relevant pages of *Philosophia Botanica*.

References

- BEADLE, N.C.W. (1971). *Students Flora of North Eastern New South Wales*. Part 1. Armidale: University of New England.
- BROWN, F.A. (1992). Asteraceae. In Harden, G.J. (ed.), *Flora of New South Wales*. 3. Kensington: New South Wales University Press.
- CAROLIN, R.C. & TINDALE, M.D. (1994). *Flora of the Sydney Region*. Chatswood: Reed.
- CURTIS, W.M. & MORRIS, D.I. (1975). *The Student's Flora of Tasmania* 1. 2nd Edition. Tasmania: Government Printer.
- DING HOU (1978). Anacardiaceae. In C.G.G.J. van STEENIS (ed.). *Flora Malesiana* ser.1,8:397–548. Djakarta: Noordhoff-Kolff.
- FILLA, F. (1926). Das Perikarp der Proteaceae. *Flora* 120:99–142.
- FLOYD, A.G. (1978). *New South Wales rainforest trees*. Pt VII. Forestry Commission of New South Wales. Research note. no 35.
- HARDEN, G.W. (1990). *Flora of New South Wales*. 1. Kensington: New South Wales University Press.
- HILL, A.W. (1933). The method of germination of seeds enclosed in a stony endocarp. *Annals of Botany* 47:873–887.
- JESSOP, J.P. & TOELKEN, H.R. (1986). *Flora of South Australia*. Pt 1. Adelaide: South Australian Government Printing Division.
- JESSUP, L.W. (1985). Anacardiaceae. *Flora of Australia* 25:170–187. Canberra: Australian Government Publishing Service.
- JOHNSON L.A.S. & BRIGGS, B.G. (1975). On the Proteaceae - the evolution and classification of a southern family. *Botanical Journal of the Linnean Society* 70:83–182.
- LINNAEUS, C. (1751). *Philosophia Botanica*. Apud Godofr. Kiessewetter, Stockholmiae. Repr.(1966). Lehre: Cramer.
- (1753). *Species Plantarum*, Tomus 1. Impensis Laurentii Salvii, Holmiae. Repr. [1957], with an Introduction by W.T.Stearn. London: Ray Society.
- MCCUSKER, A. (1981). Glossary In George, A.S. (ed.), *Flora of Australia* Vol.1: pp.169–198. Canberra: Australian Government Publishing Service.
- RAO, C.V. (1971). *Proteaceae*. New Delhi: C.S.I.R.
- REID, E.M. & CHANDLER, M.E.J. (1933). *The London Clay Flora*. London: British Museum [Nat. Hist.].
- ROTH, I. (1977). *Fruits of angiosperms*. Berlin: Gebruder Borntraeger.
- ROZEFELDS, A.C. (1990). A mid Tertiary rainforest flora from Capella, central Queensland. In Douglas, J. G. & Christophel, D.C. (eds) *Proceedings of the Third International Organization of Palaeobotany Symposium* 1988, pp.123–136. Melbourne: A-Z Printers.
- SHORT, P.S. (1999). *Chrysanthemoides*. In Walsh, N.G. & Entwistle, T.J. eds *Flora of Victoria*, Volume 4. Melbourne: Inkata Press.

- SPJUT, R.W. (1994). A Systematic Treatment of Fruit Types. *Memoirs of the New York Botanical Garden*, pp. 69–70.
- STANLEY, T.D. & ROSS, E.M. (1983). *Flora of south-east Queensland*. 1. Brisbane: Queensland Department of Primary Industries.
- STEARN, W.T. (1994). *Botanical Latin*. ed.4. Newton Abbot: David and Charles.
- STROHSCHEN, B. (1986). Contributions to the biology of useful plants. 5. Anatomical studies of fruit development and fruit classification of the monkey nut (*Hicksbeachia pinnatifolia* F.Muell.). *Angewandte Botanik* 60:249–256.
- TAKHTAJAN, A. (1991). *Evolutionary trends in flowering plants*. New York: Columbia University Press.
- WALSH, N.G. & ENTWISTLE, T. J. (1994). *Flora of Victoria* 2. Chatswood: Enkata Press.
- WESTON, P.H. (1995). *Hicksbeachia*, *Athertonia*, *Catalepidia*, in *Flora of Australia* 16: 410–416. Melbourne: CSIRO Australia.